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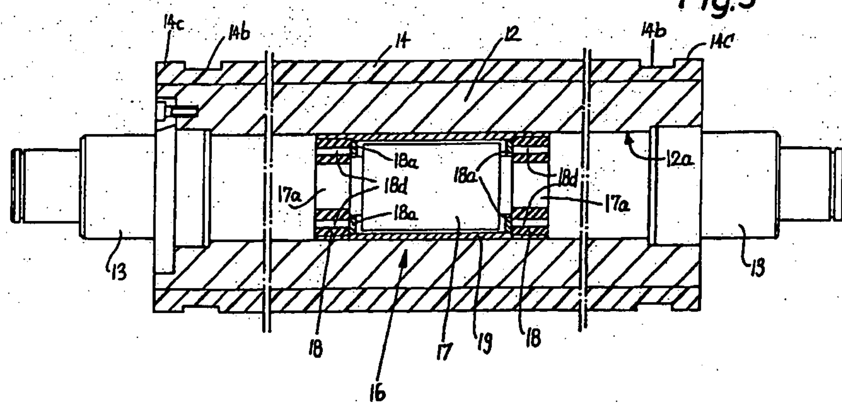
(54) Device for damping the oscillations of rotary components of printing mechanisms

(57) A mechanism which applies ink to selected portions of a running paper web preferably has an imprinting roller and a counterroller. The web travels through the nip of these rollers, and the protuberances at the periphery of the imprinting roller receive ink from a trough by way of a withdrawing roller which dips into the supply of ink in the trough and a transfer roller which delivers a film of ink from the periphery of the withdrawing roller to the protuberances of the imprinting roller. At least the imprinting roller is hollow and confines a dynamic damping system 16 whose natural oscillation frequency is attuned to that of the roller so that the system damps any oscillations of the imprinting roller when the mechanism is in use and prevents the roller being lifted from the running web. Additional damping system or systems can be installed in the counterroller, withdrawing roller and/or transfer roller.

Fig.3



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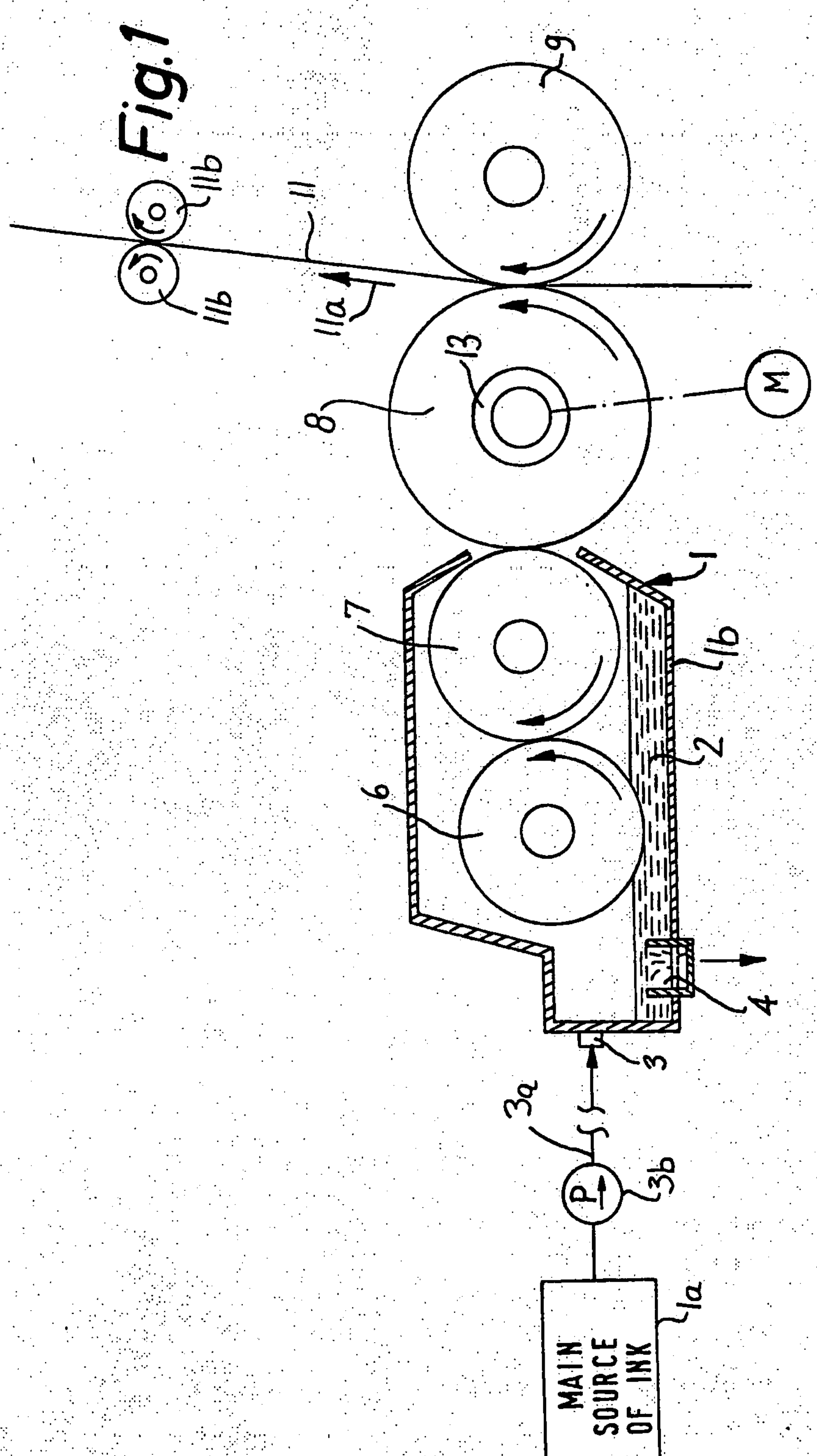


Fig.1

Fig.2a

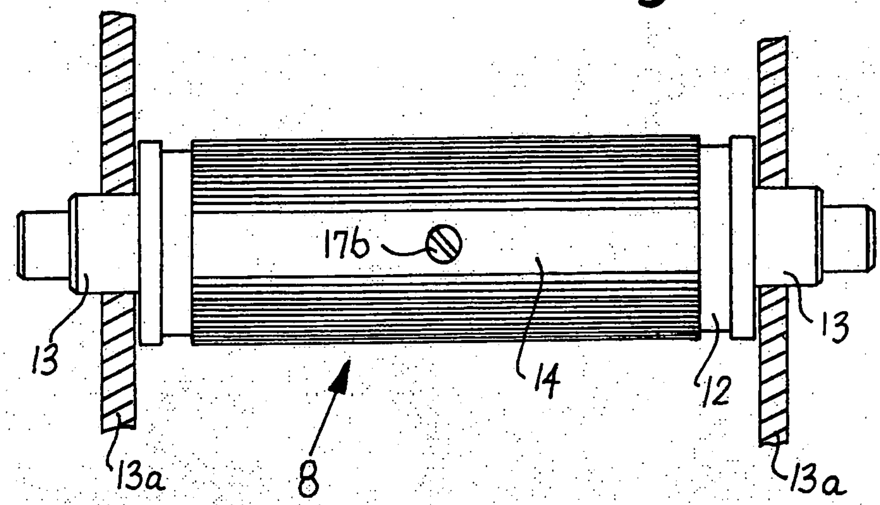
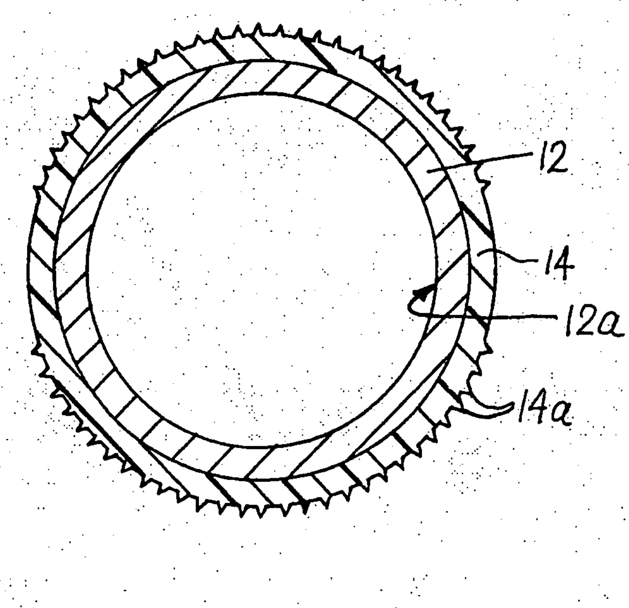


Fig.2b



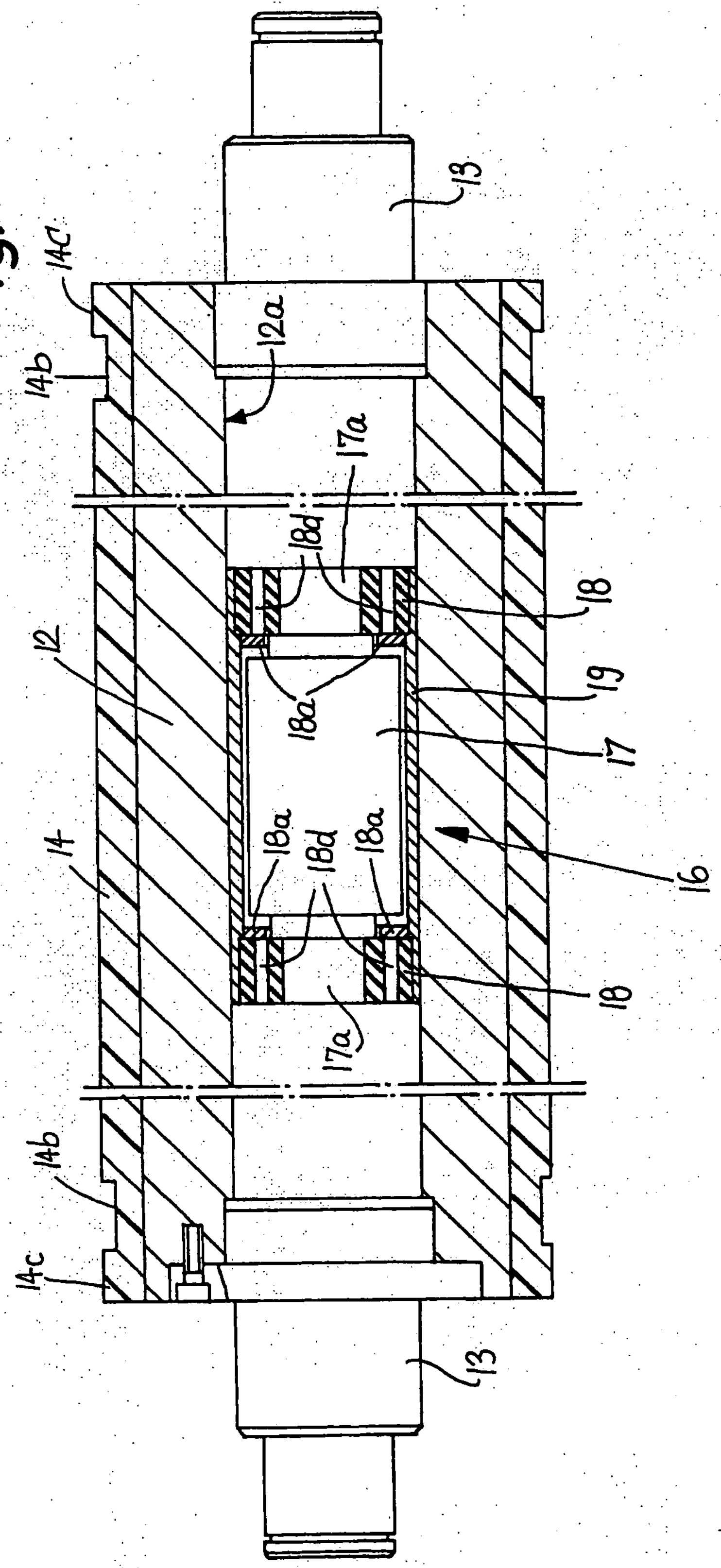


Fig.3

SPECIFICATION

Devices for damping the oscillations of rotary components of printing mechanisms for running paper webs or the like

The present invention relates to mechanisms for applying printed matter to running webs of paper or the like. More particularly, the invention relates to improvements in means for damping the oscillations of rotary components in such mechanisms during application of printed matter to running webs, strips, strands, sheets or the like. Still more particularly, the invention relates to improvements in means for damping the oscillations of imprinting, ink transferring, ink withdrawing and/or other rollers in mechanisms which are utilized to apply printed matter to continuous running paper webs or the like.

It is known to apply printed matter to webs, sheets, strips, strands, tapes or like elongated or endless commodities while the commodities (hereinafter called webs for short) are moved lengthwise through the nip of two rotary components, one of which applies printed matter to selected portions of the running web and the other of which constitutes an anvil or back support for the one component. The components are normally rollers which rotate about parallel axes transversely of the direction of lengthwise movement of the web. If the web is to be converted into sheets which are thereupon stacked, perforated and connected to each other to form pads, note books, exercise books or the like the imprinting (ink applying) roller is often formed with axially parallel peripheral projections or ridges which provide the running web with lines of printed matter so that the web can be subdivided into sheets which are ready to be assembled into ruled pads or analogous stationary articles. It is clear that the imprinting roller can have any other profile, depending on the desired configuration and/or distribution of printed matter on the running web.

It has been found that printing mechanisms having relatively small rollers (especially small-diameter imprinting rollers) are more satisfactory than those which employ larger-diameter rollers. Smaller-diameter rollers can be readily removed for inspection, cleaning, repair and/or replacement. Moreover, the space requirements of the printing mechanism can be reduced considerably if the diameters of its rollers are relatively small, especially if the printing mechanism is designed to apply ink or other coloring matter to several webs which run along discrete paths, normally one above the other. In such printing mechanisms, even a minor reduction of the diameters of rollers entails a significant reduction of the overall height and renders it possible to place the neighboring paths for two or more running webs very close to each other.

The profile at the periphery of the imprinting roller reduces its homogeneousness. In other words, the mass of the rotating imprinting roller often varies from increment to increment as considered in the circumferential direction, for example, when the periphery of such roller is formed with the aforementioned ridges which are used to apply ink or other coloring matter to selected portions of a running web which is to be converted into discrete sheets of ruled pads or the like. Thus, whenever a ridge of the imprinting roller contacts the running web, it bears indirectly (namely, through the medium of the running web) against the rotating anvil or counterroller whereby the resulting shock induces or tends to induce oscillatory movements of the imprinting roller and/or other rollers of the printing mechanism. As the rotational speed of the rollers increases, the oscillatory movements of the rollers become or are likely to become so pronounced that the imprinting roller is temporarily lifted off the running web, i.e., a ridge is likely to be moved away from the path of the web at the exact moment when it travels past the counterroller or anvil whereby the printed image on the web exhibits blank spots which are typical of low-quality stationery products. The reasons for the presence of blank spots on certain portions of the running web will be readily understood by bearing in mind that the amplitude of oscillatory movements of the imprinting roller and/or counterroller can be sufficiently pronounced (especially at elevated speeds of the rollers) to cause the width of the gap between the two rollers to exceed (at times) the thickness of the running web. Moreover, even if the amplitude of oscillations of the imprinting roller is relatively small, the image at one side of the running web can still exhibit blank spots if the amplitude of oscillations of the counterroller or anvil is more pronounced and/or if both rollers oscillate in such a way that they move apart and increase the nip therebetween at the exact moment when a ridge of the imprinting roller travels past the counterroller.

Owing to the just discussed behavior of rollers in presently known printing mechanisms for running paper webs or the like, the speed of the rollers cannot be increased at will. Therefore, such conventional printing mechanisms are likely to constitute bottlenecks in production lines wherein webs of paper or the like are withdrawn from rolls, imprinted, severed, stacked and connected to each other to form writing pads or like stationery articles. Moreover, the aforediscussed behavior or rollers in conventional printing mechanisms imposes limits upon the extent to which the diameters of the rollers can be reduced because the rollers must exhibit a certain resistance against flexing in response to the application of mechanical pressure,

under the action of centrifugal force and/or for other reasons. In other words, there exists an urgent need for a printing mechanism with rollers whose diameters are as small as or smaller than the smallest diameters of conventional rollers and which can be driven at a speed greatly exceeding the RPM of rollers in conventional printing mechanisms for paper webs or the like.

One feature of the invention resides in the provision of a mechanism for applying coloring matter (e.g., ink) to a running web of paper or the like. The mechanism comprises a plurality of rotary components, at least one of which is hollow and exhibits the tendency to oscillate at a predetermined natural frequency during rotation thereof, and a dynamic damping system which is installed in the one component and has a natural oscillation frequency attuned to that of the one component so that the system damps the oscillations of the one component when the latter rotates.

The one component may constitute an imprinting roller whose peripheral surface has one or more protuberances contacting selected portions of the running web when the printing mechanism is in use, a counterroller which is disposed opposite the imprinting roller (so that the web advances through the nip of these rollers) a withdrawing roller which dips into a supply of liquid coloring matter which is stored in a trough or another suitable receptacle, and/or a transfer roller which delivers coloring matter from the periphery of the withdrawing roller to the protuberances of the imprinting rollers.

The dynamic damping system preferably comprises a substantially cylindrical mass which is coaxial with and is confined in the interior of the respective rotary component, and means for coupling the mass to the respective rotary component so that the latter can oscillate relative to the mass, and vice versa. The coupling means comprises one or more elastic elements, and such coupling means may further comprise a cylindrical sleeve which is coaxial with and installed in the interior of the one component. The elastic elements may constitute rubber rings which are mounted on the end portions of the cylindrical mass and are installed in the sleeve so that the peripheral surface of the mass is held out of contact with the internal surface of the sleeve.

The novel features which are considered as characteristic of the invention are set forth in particular in the appended claims. The improved printing mechanism itself, however, both as to its construction and its mode of operation, together with additional features and advantages thereof, will be best understood upon perusal of the following detailed description of certain specific embodiments with reference to the accompanying drawing.

Figure 1 is a schematic partly elevational and partly longitudinal sectional view of a printing mechanism which embodies the invention;

Figure 2a is a side elevational view of the imprinting roller in the mechanism of Fig. 1;

Figure 2B is an enlarged transverse sectional view of the imprinting roller of Fig. 2a; and

Figure 3 is an enlarged fragmentary axial sectional view of the imprinting roller.

Referring first to Fig. 1, there is shown a printing mechanism for use in a machine or in a production line for the making of stationary articles, such as ruled pads, books or the like. The printing mechanism comprises a receptacle 1 (e.g., a trough) for a supply of printing ink 2 or analogous liquid coloring matter. The receptacle 1 receives ink (either continuously or at intervals) from a main source 1a by way of an inlet 3 which is connected with the discharge end of a conduit 3a containing a suitable pump 3b. An outlet 4 whose intake end is disposed at a preselected distance from the bottom wall 1b of the receptacle 1 ensures that the height of the supply of ink 2 in the receptacle is constant or nearly constant even though a certain amount of ink is continuously withdrawn by the peripheral surface of a withdrawing roller 6 which dips into the supply of ink in the receptacle and delivers a film of ink to the peripheral surface of an ink transferring roller 7 (hereinafter called transfer roller for short). The roller 7, in turn, delivers ink to selected portions of the profile at the periphery of an imprinting roller 8 which is adjacent to the path of movement of a continuous paper web 11. The latter is transported in the direction indicated by arrow 11a, e.g., by two advancing rolls 11b, at least one of which is driven to rotate in the indicated direction whereby the web 11 travels in the direction of the arrow 11a. The imprinting roller 8 cooperates with a complementary roller or counterroller 9 which constitutes an anvil for the protuberances at the periphery of the imprinting roller. The web 11 advances through the nip of the rollers 8 and 9 and one side thereof is provided with a printed image, e.g., a series of parallel lines which extend at right angles to the plane of Fig. 1. As stated above, the nature of the printed image depends on the intended use of the web 11; it may consist of parallel lines, it may include such lines plus numerals or other indicia, or it may merely consist of indicia (i.e., printed matter other than lines). The directions in which the rollers 6, 7, 8 and 9 rotate are indicated by arrows. The reference character M denotes a prime mover for at least one of the rollers 6–9, e.g., for the roller 8. If the prime mover M drives only one of the rollers, the other rollers can receive torque by way of a suitable gear train in such a way that the rollers 6, 7 rotate in opposite directions, that the rollers 7, 8 rotate in opposite directions,

and that the rollers 8, 9 rotate in opposite directions.

It is further clear that the number of rollers in the printing mechanism can be reduced below or increased above four. For example, the roller 6 can apply ink directly to the protuberances of the imprinting roller 8, or the printing mechanism can comprise one or more additional transfer rollers between the rollers 6 and 7 or 7 and 8. The provision of at least one transfer roller is desirable in many instances because it ensures a more uniform transfer of predetermined quantities of ink to each and every protuberance at the periphery of the imprinting roller 8. The nip of the rollers 8 and 9 should be just wide enough to permit the web 11 to pass therethrough while simultaneously ensuring that each and every protuberance at the periphery of the roller 8 will apply ink to the adjacent portion of the running web 11 when the respective protuberance travels past the nine o'clock position of the counterroller 9, as viewed in Fig. 1.

Certain details of the imprinting roller 8 are shown in Figs. 2a and 2b. As mentioned above, this roller is intended to provide the running web 11 with lines which extend at right angles to the longitudinal direction of the web. The thus ruled web is then severed, either transversely or transversely and lengthwise, to yield discrete sheets which are stacked and connected to each other. For example, each stack can be formed with a row of marginal perforations for the convolutions of a spiral binder or for the ring-shaped portions of a so-called twin-wire binder (also known as Wire-O binder).

The imprinting roller 8 comprises an elongated hollow cylindrical member 12 whose end portions are connected with the stubs or trunnions 13 of a composite shaft. The trunnions 13 are journalled in a frame 13a of the printing mechanism (such frame can form part of the receptacle 1, see Fig. 1) and the composite shaft is driven by the aforementioned prime mover M. Alternatively, the prime mover can transmit torque to a gear (not shown) which is mounted adjacent to the one or the other trunnion 13. The cylindrical member 12 constitutes a hollow tubular support for a liner 14 which is an envelope surrounding the peripheral surface of the member 12 intermediate the trunnions 13 and having a ribbed profile whose protuberances or ridges 14a are parallel to the common axis of the trunnions 13 and cylindrical member 12 and serve to apply lines of ink to the running web 11. The top lands of the ridges 14a receive films of ink from the peripheral surface of the transfer roller 7.

The construction of the rollers 6, 7 and 9 may but need not be similar to that of the roller 8 except, of course, that the rollers 6, 7 and 9 need not be provided with the peripheral liner 14 of Figs. 2a and 2b.

It will be noted (see Fig. 1) that the outer diameter of the imprinting roller 8 exceeds the outer diameter of the counterroller 9, and that the outer diameter of the counterroller 9 exceeds the outer diameters of the rollers 6 and 7. This is a presently preferred design of the printing mechanism; however, it is evident that the outer diameters of all rollers may be identical or that the outer diameter of the roller 8 need not exceed the outer diameters of the other rollers.

The cylindrical member 12 preferably consists of a suitable metallic material, and the liner 14 may but need not consist of a synthetic plastic material. It is also possible to make all component parts of the roller 8 and/or roller 9 and/or roller 6 and/or roller 8 of a metallic or plastic material.

Referring now to Fig. 3, it will be noted that the axial length of the liner 14 matches that of the hollow cylindrical member 12. The ridges 14a are provided in the central portion of the liner 14 between two circumferential grooves 14b which separate the ridges 14a from the flanges 14c at the respective axial ends of the liner.

Fig. 3 further shows that the axial passage 12a or internal space of the cylindrical member 12 contains a dynamic damping system 16 which is designed to prevent oscillatory movements of the roller 8 or to maintain the extent (especially amplitude) of such movements within a range which is sufficient narrow to prevent the oscillations from interfering with proper operation of the printing mechanism.

The dynamic damping system 16 comprises a cylindrical mass 17 having smaller-diameter end portions or stubs 17a, and means for coupling the mass 17 to the cylindrical member 12. In the illustrated embodiment, the coupling means comprises two elastic elements 18 in the form of rings which surround the respective end portions 17a and are installed in the respective end zones of a cylindrical sleeve 19. The sleeve 19 can be said to form part of the coupling means for the mass 17 and is fixedly installed in the passage 12a wherein it is held by one or more fasteners in the form of screws 17b, bolts or the like (see Fig. 2a). Metallic washers 18a can be placed adjacent to the inner sides of the elastic rings 18. The purpose of the rings 18 is to ensure that the mass 17 can oscillate freely with respect to the cylindrical member 12, or vice versa. To this end, the rings 18 maintain the peripheral surface of the cylindrical mass 17 out of contact with the internal surface of the sleeve 19, i.e., out of contact with the surface surrounding the axial passage 12a of the cylindrical member 12.

The mass 17 consists of or includes a suitable metallic material. The rings 18 may be made of rubber or elastomeric synthetic plastic material. It is also possible to replace

the rubber rings 18 with other types of elastic elements which serve the same purpose, i.e., of coupling the mass 17 with the cylindrical member 12 so that these parts can freely oscillate with reference to each other. For example, the rings 18 can be replaced by cushions which consist (either entirely or in part) of filameteray metallic material and surround the end portions 17a of the mass 17. Each of these end portions can be surrounded by a single cushion or by two or more cushions. Cushions of filamentary metallic material which can be used as a substitute for the rings 18 of Fig. 3 are distributed, for example, by the firm Stop-Choc of Magstadt, Federal Republic Germany.

The sleeve 19 (which can consist of a suitable metallic material) is optional, i.e., the coupling means may include or consist solely of elastic elements which are dimensioned and distributed in such a way that they maintain the peripheral surface of the mass 17 out of contact with the surface surrounding the passage 12a. An advantage of the sleeve 19 (which can be properly held in the cylindrical member 12 by a single fastener 17b or by a relatively small number of fasteners) is that the entire dynamic damping system 16 can be assembled, in the form of a prefabricated module, outside of the cylindrical member 12 and is thereupon adjusted so that the natural oscillation frequency of the mass 17 is properly attuned to that of the imprinting roller 8. The thus adjusted or modified damping system 16 is then inserted into the passage 12a and is fixed in selected position by the fastener or fasteners 17b.

It has been found that the system 16 ensures rapid and effective damping of oscillatory movements of the imprinting roller 8, even if the outer diameter of the roller 8 is much smaller than in heretofore known printing mechanisms and even if the RMP of the rollers 6, 7, 8 and 9 is much higher than in conventional printing mechanisms. As mentioned above, the roller 8 tends to oscillate at its natural frequency when the top lands of the ridges 14a strike against the peripheral surface of the counterroller 9 through the medium of the running web 11, i.e., when such ridges apply lines of ink to the material of the web at that side which faces the roller 8. The amplitude of natural frequency oscillations of the roller 8 could reach a value at which at least some of the ridges 14a would fail to contact the respective side of the web 11 during travel of such ridges past the counterroller, 9. The improved printing mechanism applies identical images to successive unit lengths of the running web 11 even if the RPM of its rollers is substantially higher than in heretofore known printing mechanisms and even if the diameter of the roller 8 is not greater (but actually less) than the diameter of the imprinting roller in a conventional mechanism. This is particularly important in printing mechanisms wherein two or more pairs of rollers 8 and 9 are disposed at different levels so as to apply printed matter to two or more webs which may but need not run along parallel paths. The dimensions (particularly height) of such multiplex printing mechanisms can be reduced considerably if they utilize rollers having relatively small diameters.

The natural oscillation frequency of the dynamic damping system 16 can be selected in advance in such a way that it is optimally attuned to that of the roller 8. Alternatively, the natural frequency of the damping system 16 can be adjusted so that it is properly related to that of the imprinting roller 8. For example, the natural oscillation frequency of the damping system 16 can be varied by replacing the mass 17 with a mass having different dimensions, specific weight and/or other characteristics. Alternatively, or in addition to the just mentioned adjustment of natural oscillation frequency, it is possible to adjust such frequency be appropriate selection of the spring constant of the coupling elements 18 and/or similar or otherwise configurated elastic coupling elements. Moreover, vibratory movements of elastic elements which consist of rubber or a similar elastomeric material can be determined in advance by appropriate selection of their material and/or by resorting to other measures, e.g., by appropriate selection of the configuration of ring-shaped elastic elements which are made of rubber or the like. For example, oscillations of rubber rings can be selected or varied within a desired range by the provision of axially parallel holes or bores (shown by broken lines, as at 18d) which form annuli around the respective end portions 17a of the cylindrical mass 17. The axes of the bores 18d are parallel to the common axis of the mass 17 and cylindrical member 12 of the roller 8.

It has been found that the operation of the printing mechanism can be improved still further, or that the operation of such mechanism can be improved to be superior to that of conventional printing mechanisms, if the improved mechanism is provided with several dynamic damping systems, for example, with a discrete damping system for each of the rollers 8, 9, with a discrete damping system for each of the rollers 7, 8, with a discrete damping system for each of the rollers 6, 8, with a discrete damping system for each of the rollers 6, 7, 8 or 6, 8, 9 or 7, 8, 9, or with a discrete damping system for each of the rollers 6–9. It is further within the purview of the invention to provide a damping system for the roller 6, 7 or 9, to provide damping systems for the rollers 6 and 7 or 6 and 9 or 7 and 9, or to provide damping systems for the rollers 6, 7 and 9. In other words, at least some improvements in operation of the printing mechanism can be de-

tected even if the imprinting roller 8 does not embody a dynamic damping system, as long as at least one other roller of the printing mechanism is equipped with the system 16 or an analogous dynamic damping system.

Each roller which embodies a dynamic damping system includes a hollow tubular support which constitutes or corresponds to the cylindrical member 12 of Fig. 3, and a dynamic damping system which is installed in the interior of the hollow tubular support and whose natural oscillation frequency is adequately attuned to that of the imprinting roller 8 and/or to the natural oscillation frequency of the corresponding roller (namely, the roller in whose support the damping system is installed).

It has been found that the operation of the printing mechanism is quieter and that the likelihood of development of blank spots on the running web or webs is reduced still further if such mechanism is provided with at least two discrete dynamic damping systems, especially if one of these systems is installed in the cylindrical member of the imprinting roller. The operation is especially satisfactory, and the likelihood of improper operation at extremely high rotational speeds (even if the outer diameters of the rollers are extremely small) is even less pronounced, if the printing mechanism comprises a relatively large number of discrete damping systems, especially a discrete damping system for each roller. As mentioned above, all of the dynamic damping systems (if the mechanism comprises two or more damping systems) may be of identical design or they may be of similar design (including the dimensions of their components). Therefore, the drawing does not illustrate the damping system or systems which are or which may be installed in the tubular support of the roller 6, 7 and/or 9.

It is preferred to install the dynamic damping system 16 or an analogous damping system in that portion of the respective tubular support which is subject to flexure-induced oscillations of maximum amplitude. For example, if the roller is likely to flex at a maximum amplitude in the central portion between its trunnions, the damping system is installed midway between the axial ends of the respective tubular support. This greatly reduces the amplitude of (or completely eliminates) flexure-induced oscillations of the roller or rollers.

The improved printing system runs very quietly because of the absence of oscillations (or due to pronounced reduction of the amplitude of oscillations) of its rollers. This invariably improves the quality of the printed image which is applied to one side of the running web.

The special advantage of the invention is shown by the following example. It has been provided a printing arrangement shown in Fig. 1. The outer diameter of the printing roller 8 was 111 mm. The outer diameter is predetermined by the circumference of the printing roller which depends on the size of the desired product.

The cylindrical member 12 consisted of metal and had an outer diameter of 90 mm. The outer diameter of the sleeve 19 was 65 mm. The length of the printing roller was 1400 mm and the length of the damping system 16 was 200 mm. The diameters of the other rollers were 157 mm. Only the printing roller was provided with a damping system corresponding to the invention. The rotating speed of the printing roller according to the invention could be increased up to 30 percent over the maximum rotating speed of conventional printing rollers without quality impairment of the printed image.

CLAIMS

1. In a mechanism for applying coloring matter to a running web of paper or the like, the combination of a plurality of rotary components at least one of which is hollow and exhibits the tendency to oscillate at a predetermined natural frequency during rotation thereof; and a dynamic damping system installed in said one component and having a natural oscillation frequency which is attuned to that of said one component.

2. The combination of claim 1, wherein said rotary components include an imprinting roller and a counterroller, said rollers defining a nip for the transport of the web therethrough and one of said rollers constituting said one rotary component.

3. The combination of claim 2, wherein said one roller is said imprinting roller.

4. The combination of claim 2, wherein said one roller is said counterroller.

5. The combination of claim 1, wherein said rotary components include an imprinting roller which is immediately adjacent to said path and a second roller arranged to transfer liquid coloring matter to selected peripheral portions of said imprinting roller, one of said rollers constituting said one rotary component.

6. The combination of claim 5, wherein said one roller is said second roller.

7. The combination of claim 1, further comprising a reservoir for a supply of liquid coloring matter, said rotary components including an imprinting roller which is immediately adjacent to one side of said path and means for delivering coloring matter from said reservoir to selected peripheral portions of said imprinting roller, said delivering means including a second roller which dips into the coloring matter in said reservoir, one of said rollers constituting said one rotary component.

8. The combination of claim 7, wherein said one roller is said second roller.

9. The combination of claim 1, wherein said one component is a roller including a hollow tubular support and said damping sys-

tem includes a mass disposed in the interior of said support and means for coupling said mass to said support so that the latter is free to oscillate relative to said mass and vice versa.

10. The combination of claim 9, wherein said coupling means includes elastic elements.

11. The combination of claim 10, wherein said mass is a cylinder and said coupling means further comprises a sleeve coaxial with and installed in said roller, said elastic elements being disposed between said mass and said sleeve so as to maintain the mass out of direct contact with the sleeve.

12. The combination of claim 11, wherein said support has an axial passage and said sleeve is disposed in said passage.

13. The combination of claim 10, wherein at least one of said elements is a ring.

14. The combination of claim 10, wherein said mass is a cylinder having first and second end portions and said elastic elements include rings surrounding the end portions of said cylinder.

15. The combination of claim 1, wherein said one component is a roller including a hollow portion which is subject to maximal flexural stresses when said roller is driven, said damping system being installed in said hollow portion.

16. The combination of claim 1, wherein said rotary components are rollers including an imprinting roller which is immediately adjacent to one side of said path and at least one additional roller, said imprinting roller constituting said one component.

17. The combination of claim 16, wherein said additional roller is hollow and further comprising a second dynamic damping system installed in said additional roller, said additional roller tending to oscillate at a given natural frequency in response to rotation thereof and said second damping system having a natural oscillation frequency attuned to said given frequency.

18. The combination of claim 1, wherein the number of said rotary components exceeds two and at least two of said components are hollow, and further comprising an additional dynamic damping system for the other hollow component.

19. The combination of claim 1, wherein said components are rotatable about parallel axes and said one component has a peripheral surface and at least one protuberance on said surface.

20. In a mechanism for applying coloring matter to a running web of paper or the like, the combination of a plurality of rotary components, substantially as herein described with reference to and as illustrated in the accompanying drawings.

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